

from St. Vincent, but is I think sufficiently distinguished by the following characters:—the fine acute spines of the penultimate and terminal segments are here replaced by conical or rounded tubercles, and the posterior half of the antepenultimate segment, which is represented as smooth and entire in *G. bradyi*, is granulated in *G. trachurus* on the dorsal surface and minutely spinulose on the posterior margin.

EXPLANATION OF PLATE I.

Fig. 1. *Callianassa martensi*, sp. n., male, $\times 1\frac{1}{2}$ diam. (p. 13).

- 1a. Frontal region and antennæ of the same species, showing the form of the frontal spines, $\times 3$ diam.
- 1 b. Extremity of one of the legs of the third pair, showing the form of the produced posterior lobe of the penultimate joint and of the dactylus, $\times 4$ diam.
- 1 c. Terminal segment and uropoda, $\times 3$ diam.
2. Terminal segment and uropoda of *C. mauritiana*, enlarged.
- 2 a. Larger chelipede of *Callianassa mauritiana*, Miers, natural size.
3. *Gonodactylus trachurus*, v. Martens, adult male, $\times 2$ diam. (p. 16).
- 3a. Raptorial limb (second maxillipede) of the same species, $\times 3$ diam.

4. On Races and Hybrids among the *Salmonidæ*.

By FRANCIS DAY, F.Z.S.

[Received December 24, 1883.]

In March 1882 I laid before the Linnean Society the results of some observations which I had made on the British Salmonidæ, tending to show that the number of species existing in these islands had been unduly multiplied by local races or varieties having been considered species. In the month of December I communicated to this Society some facts respecting the hybridization of Salmon and Trout, and likewise adverted to Sir J. Gibson-Maitland, Bart., F.L.S., having kindly instituted, on November 15th, 1882, three additional experiments upon crossing different forms of Charr, or Charr with Trout, the results of which, so far as they have gone, I propose describing this evening.

I have also to thank Sir J. Gibson-Maitland for permitting me to take examples of all the various crosses which have been made at Howietoun (many of which are on the table for examination), while he has also freely furnished me with information on all points, and access to his notes. There are likewise a series of Salmonidæ hatched in the great International Fisheries Exhibition, from eggs brought from Canada by Mr. Wilmot, the Canadian Commissioner, who gave me specimens at short intervals, so that I have a connective series. I shall have to refer to a pair of fine Trout sent to me in ice from the Otago Acclimatization Society, through the kind offices of Mr. Arthur, which are now preserved in spirit in the Economic Fish Museum at South Kensington. Lastly, I shall describe the *Salmo gracilis* of Couch (? Cuv. & Val.), a local race which I had the

opportunity of examining along the coast of Devonshire during the past half-year.

The first specimen I propose describing is a hybrid between *Salmo salar* and *S. leuvenensis*. On November 25th, 1879, as detailed by me previously (Proc. Zool. Soc. 1882, p. 751), a man arrived at Howietoun, sent over from Stirling by Mr. Napier, with some Salmon-milt obtained the previous night, and this was employed for the purpose of fertilizing some eggs from a 4-year-old Lochleven Trout. It is necessary to draw attention to the fact that the milt came from the Salmon, as the size of the spermatozoa is such as to generally render impregnation of Trout-eggs difficult in the natural state. But here the milt had been brought in a bottle packed in snow or ice, and although the cold may have caused the size of the spermatozooids to contract, it appears to me more probable that the large eggs of these Trout possessed a comparatively large micropyle. Perhaps, as we find parr full of milt during the Trout-spawning season, the size of the spermatozooids preclude their impregnating the majority of the Trout-eggs which would be on the beds; for, although it has been computed that the absorbing powers of the ova extend over 30 minutes, the period during which the spermatozooids are alive in water is about $2\frac{1}{2}$ minutes, and it is probable that for such a time the male Trout would hardly permit a parr to interfere with the redd.

One of the progeny of the above experiment, 11 inches in length, was captured in my presence at Howietoun, November 14th, 1882, and I subsequently described it in full (*l. c.*). In the island-pond two years since some more (which were the smallest fish) were placed, and when this pond was drained on November 28th, 1883, several were obtained. I sent three to the Economic Fish Museum at South Kensington; one I retained for personal examination. The specimen is on the table, and, although a year older than the one I described in 1882, is of the same length, while the others were slightly smaller; and investigations into the rapidity of the growth of these fish will form a subject for inquiry next year among those which still remain.

B. x. D. 12 ($\frac{3}{8}$). P. 13. V. 10. A. 11 ($\frac{3}{8}$). C. 19.
L. l. 114. L. tr. 24/32. Cæc. pyl. 69.

	inches.
Total length of specimen	11·0
Length of head	2·0
Length of pectoral fin	1·5
Distance from snout to base of dorsal fin	4·2
Distance from snout to centre of base of caudal fin	9·0
Diameter of eye	0·4
Distance of eye from end of snout	0·6
Distance of eyes apart	0·7
Height of body	2·5

Preopercle forming an almost regular curve, with but very little appearance of a lower limb. Lower jaw very slightly hooked at its

extremity; a line from the end of the snout to the further point of the posterior end of the opercle passes just below the orbit; half the length of the upper edge of the subopercle equals its greatest depth. Maxilla of moderate strength, and reaching to below the hind edge of the orbit. *Teeth*—in a double row of about 6 on either side, pass along the anterior two thirds of the body of the vomer, while some are also on its head. *Scales*—12 rows pass downwards and forwards from the hind edge of the adipose dorsal fin to the lateral line; 21 rows pass from the lateral line to the base of the ventral fin. Rows of scales near the hind end of the fish irregular. *Colours*: very silvery, like a grilse, with 6 or 7 irregularly distributed rows of black spots on the anterior portion and upper two thirds of the body, decreasing to 3 or 4 at the end of the caudal region; no parr-marks on the sides. Two large black spots on the hind edge of the preopercle, 5 on the opercle, and 1 on the subopercle. A few small black spots on the top of the head. Lower two thirds of dorsal fin with large black spots and a white anterior upper edge; the fins generally greyish and darkest in the centre, the anal having a light front edge. Cæcal appendages of moderate size. Sex, male. Generative organs rudimentary.

Last year I also adverted in the same communication to 20,000 eggs of Lochleven Trout having been fertilized with Salmon-milt by Sir J. Gibson-Maitland on December 24th, 1881. These eggs were hatched on March 9th, 1882, or in 75 days, and on November 15th, 1882, about 1250 young were alive. I exhibited four specimens, varying in length from 3·4 to 4·3 inches. These fish have continued to do well, and are thriving in the upper and centre planked ponds at Howietoun, upwards of 800 being alive.

I obtained three specimens (on the table), which give the following measurements:—

B. x-xi. D. 13 ($\frac{3}{10}$). P. 14. V. 9-10.
A. 11 ($\frac{3}{8}$). C. 21. L. l. 118.

	No. 1.	No. 2.	No. 3.
	in.	in.	in.
Total length of specimens	7·3	5·7	5·4
„ „ head	1·6	1·2	1·15
„ „ pectoral fin	1·05	1·0	0·9
„ „ caudal fin	1·3	0·9	0·9
Distance from snout to base of dorsal fin	2·8	2·2	2·2
„ „ „ centre of base of			
caudal fin	6·2	4·9	4·6
Diameter of eye	0·3	0·23	0·25
Distance of eye from end of snout.	0·5	0·33	0·3
Distance of eyes apart	0·6	0·4	0·4
Height of body	1·5	1·2	1·0

Specimen no. 1 had the teeth in a double row along the body of the vomer. In examining the extent of the emargination of the caudal fin, it was 0·5 of an inch, while the length of the outer ray was

1.3 inch. *Scales*—12 rows between the adipose dorsal fin and lateral line. The direction of the rows of scales on the body rather irregular in places. Of a silvery colour along the back and sides, the upper half or two thirds of the body being spotted with black, some large red spots along the lateral line; three black spots on the opercle, and a fourth at its upper corner; one also on the preopercle. In certain lights 12 finger or parr-marks may be observed along either side; dorsal fin grey, with a white anterior edge at its upper margin, its lower half spotted with black; adipose dorsal orange, with a grey front edge; the other fins unspotted.

Specimen no. 2 was nearly similar in colour to no. 1, but a little more yellow; while it had 10 finger-marks on one side and 12 on the other; 14 rows of scales between the adipose dorsal fin and the lateral line; while the direction of the rows of scales on the body was irregular.

Specimen no. 3 was similarly coloured, except being still more yellow; it had 10 finger-marks on one side and 11 on the other; 2 black spots on the preopercle and 3 on the opercle; also many red spots on the body.

In these three undoubted hybrids the number of parr-bands along the sides varied from 10 to 12, while the direction of the rows of scales showed great irregularity. Both had 118 along the lateral line; but on the side of the tail they varied from 12 to 14 between the adipose dorsal and the lateral line.

Respecting the rate of growth of these fish as compared with young Salmon, it was found that the largest was a little over 7 inches long; while young *Salmo salar* in the next pond, a year older, were from 4 to 13½ inches in length.

Examples of young Salmon (*Salmo salar*) are at present at Howietoun in pond C, which is 130 feet long and has boarded edges. The eggs and nilt from which these fish were raised were obtained by Sir J. Gibson-Maitland from the Teith in December 1880, and hatched at Howietoun in March 1881. There are a considerable number in the pond, and they have developed some very interesting phenomena. In July this year, in the presence of the foreign and other commissioners to the Fisheries Exhibition, this pond was netted, when it was seen that some of the young fish, then 2 years and 4 months old, were golden, spotted, and in the banded parr-stage, while others were beautiful silvery smolts almost ready to descend to the sea. Some of these parr-marked fish exceeded those which were in the smolt livery in size, although this was the exception.

During the first week in October one of these fish, under a pound in weight, and in the smolt colours, but with the parr-bands still visible in certain lights, jumped out of the pond and was found dead. On being opened it turned out to be a female with comparatively large ova, which were of a deep reddish colour—thus almost disposing of the statement that “no parr has ever been found with mature ova”¹. Certainly the ova were not mature, but would have

¹ Günther, ‘Introduction to the Study of Fish,’ p. 639.

been had the fish not met with an untimely end; while the parr-marks were present, and so likewise were the silvery scales of the smolt. And as I shall show, we found at the end of November other females with ova, in all of which the parr-marks were visible.

At the end of November, when again at Howietoun, I was informed that several of the fish during the night or early morning had jumped out of the pond, and it was surmised that many had so perished, but been carried off in the early hours by birds and rats. At my first visit I was shown one which had been found dead that morning, and on the 29th there were two more, one of which (11·5 inches in length) had been partially eaten by some vermin, which had devoured the lower portion of its head. It was of a silvery smolt colour with parr-marks. On being opened it proved to be a male full of ripe milt¹. A net was drawn through this pond for the purpose of examining the condition of the fish, and obtaining ova if possible, as well as milt for experimenting with. I examined three specimens, which are on the table:—

B. xi. D. $\frac{3}{11}$. P. 14. V. 9. A. $\frac{3}{8}$.
C. 21. L. l. 117. L. tr. 21/30.

	No. 1. in.	No. 2. in.	No. 3. in.
Total length of specimens.	10·8	9·0	6·3
Length of head.	2·0	1·8	1·3
„ pectoral fin	1·4	1·25	1·15
„ caudal	1·8	1·6	1·15
Distance from snout to base of dorsal fin . .	4·1	3·5	2·5
„ „ „ centre of base of caudal fin	9·3	7·9	5·2
Diameter of eye.	0·4	0·45	0·25
Distance of eye from end of snout	0·6	0·55	0·3
„ eyes apart	0·7	0·65	0·45
Height of body	2·0	1·8	1·3

No. 1 was a beautiful silvery smolt with ten distinct parr-marks when placed in certain lights. One black spot on the preopercle, three on the opercle; the upper two thirds or half of the body spotted with black, as was likewise the lower half of the dorsal fin, which had a white anterior and outer edge. Pectoral fin nearly black in all these fish when alive. In this specimen the generative organs were not developed. The maxilla was more slender than in the hybrid of almost the same size, and which has been described. *Scales*: 11 rows from the adipose dorsal fin to the lateral line, and 20 rows from the lateral line to the base of the ventral fin. The extent of the cleft of the tail was 0·8, and the length of its longest ray 1·8. Its cæcal appendages were longer than in the hybrids.

¹ “I am not quite sure but that milt and ova might be found in a hybrid; it has been found in parrs, and my theory is, that when this is so, the fish is the produce of a hen Salmon and a male river-Trout, as it was frequently found that a hen Salmon was spawning on the same gravel-bed with a male river-Trout.”—Günther, evidence given June 4th, 1872, in ‘The Parr and Salmon Controversy.’ (Second Edition, 1883, page 128.)

No. 2 was more distinctly parr-marked, but otherwise very similar. It had 11 rows of scales between the adipose dorsal fin and the lateral line, as seen in the larger specimen. 19 rows of scales between the lateral line and base of ventral fin. The extent of the cleft of its caudal fin was 0.9, and the length of the longest ray 1.6.

No. 3 was in the parr livery with 10 well-marked finger-spots on either side, 3 black spots on the opercle. Fins as in the others, anal greyish in the centre. The upper jaw in the specimen a little shortened, due to injury. 11 scales in an oblique row from the soft dorsal fin to the lateral line. The fish was a male full of milt.

As a rule, the females were silvery, and were found to have ova, but not quite ripe, requiring from 4 to 6 weeks more. The males, on the contrary, on being pressed, gave ripe milt. The Salmonoids in these ponds seem to be more spotted than such as are obtained from rivers, and though perhaps not of large size are well proportioned. The largest taken in the net was 13.5 inches in length. As a rule, fish in the parr livery seemed to be males, most of which were ripe, while the silvery smolts were generally females; the finger-marks in all were perceptible. These fish made it very evident that the relative growth of the fry does not depend on the size of the pond, quantity of food, or amount of water, as all had been treated alike, yet they varied in length from 4 to 13½ inches.

Various reasons have been adduced in order to explain why a parr on becoming a smolt (normally about to migrate seawards) becomes of a silvery colour. Davy ('Philosophical Researches,' 1843, p. 250) suggested of the Salmon "that the young remain in fresh water till they have acquired not only a certain size and strength, but also additional scales, fitting them in their smolt stage to endure without injury the contact of the saline medium." Whether by acquiring "additional scales" he intended to mean an additional coat of scales, may be open to discussion, but as the body of the parr is fully scaled, such would appear to be the meaning. Couch, in 1866, observed that the silvery colour of Smolts is not due to their acquiring additional scales, but owing to a deposit of bright soft matter, which shines through the transparent scales. Günther (Intr. Study of Fishes, 1881, p. 632), however, remarks, respecting the river-Trout, that they "frequently retain the parr-marks all their lifetime; at certain seasons a new coat of scales overlays the parr-marks, rendering them invisible for a time, but they reappear in time, or are distinct as soon as the scales are removed. When the Salmones have passed this Parr-stage," we are distinctly informed that "a new coat of scales overlays the parr-marks;" but as these fish do not shed their scales, he seems to advance that an additional or extra coat of scales is developed at certain periods, an opinion, as I believe, held by Davy, but denied by Couch¹.

¹ I have received the following communication from Dr. Gadov:—"The development of the scales in Teleostean fishes, as in the Salmon, &c., is as follows:—The cutis (together with the superimposed epidermis) at first forms a slight elevation, the upper or top end of which assumes a backward direction, and this growing or young scale soon ossifies, but not so completely as in Sharks

On examining an American Charr, *Salmo fontinalis*, in the parr-stage, and $3\frac{1}{2}$ inches in length, the scales covering the body on their outer surface were found to be covered and bound down to one another by a covering of epidermis (which in its turn was much concealed by a thick layer of mucus); the same appearance was present in a *Salmo levenensis* 4 inches in length, while in a Salmon-parr, 6 inches long, a change had commenced in some regions of the body. The hind portion of the exposed part of each scale, sometimes to as much as one third or even one half, being silvery, or rather transparent, permitting the silvery lustre to shine through, but not so the basal portion, which retained more of the parr-colour. On placing a needle under these scales, the transparent or silvery part could be readily elevated; it was no longer bound down by epidermis, as in younger fish, while but very little mucus was present. Among the silvery smolts this apparent denudation of the scales had been carried to a greater extent, the epidermis being seemingly merely present across its base (except where black or orange spots existed), and as a consequence a silvery scale with more or less dark edges was seen. Should the scale of a smolt be raised, it appears as if on the sides and most of the body of the fish it were merely attached at its base and placed in a pocket of the epidermis, and nowhere in the body is any new layer of scales developed, or an increased thickness put on, but, on the contrary, the epidermal covering seems to become removed in the smolt-stage, thus occasioning their transparent and consequent silvery appearance, which is continued through life. Owing to the epidermis being less removed from the scales of the back, and being present over the scaleless head, these portions retain a darker colour.

A hybrid between *S. salar* and *S. levenensis*, at 7.4 inches in length, shows a portion of the outer edge of each scale already denuded of epidermis; and although I do not propose in this paper to enter upon the question of colour, I may remark that the lateral bands or finger-marks come into more prominent view when the scales and attached epidermis are removed, rendering it probable that they are found in the cutis. The black spots, or at least some of those which are seen on the body, are in the epidermis, and can be removed with that structure; while on removing a scale, the epidermal pocket in which its base lies is found of a dark and often black colour. If the epidermis of a young fish is placed under the microscope, it is more or less filled with fine black dots; consequently the absorption of this structure, irrespective of its leaving the silvery portion uncovered, removes what must add a darker tinge to the fish. In like manner a portion of the red or orange dots may be external to the scales, as in the epidermis or in the structures below

and Ganoids. The scales increase in size by apposition, their basal portion forming the matrix being part of the cutis, in a similar way to finger-nails growing out of the nail-fold. There are two main classes of these scales, one retaining an embryonic condition, as in some parts of a Mackerel, &c., while those of the Salmon, which attain a larger size, break through the epidermal layer, and thus become partially free."

them; while the male Salmon-parrs at Howietoun have developed a white anterior edge to the dorsal and anal fins.

These young migratory Salmon conclusively show that the females, without descending to the sea, may develop eggs in fresh water. And though we know that in the case of rivers in which their access to the sea has been cut off, or their migrating to the ocean prevented from any cause, these fish have usually disappeared from such streams, still we are aware that land-locked Salmon are found in various parts of the globe. It does not seem a visionary dream, but within the bounds of a measurable distance, to anticipate that some Howietoun-reared fish may in a few generations develop land-locked forms, invaluable to the upper waters of some of our rivers in which migrations seaward are now impossible; while they will also afford the upper riparian proprietors a chance of securing a breed that will remain in their waters, and cannot therefore be destroyed, as they are now at the mouths of rivers, and in the estuaries, by unscrupulous fishing.

Before proceeding to discuss the use made of the milt of these fishes, I propose adverting to another series of Salmon, bred at the Fisheries Exhibition, from eggs brought from Canada by Mr. Wilmot, the Canadian Commissioner, who has kindly given me a series.

For the purpose of exhibiting the interesting modes of fish-hatching now being carried on in Canada, Mr. Wilmot brought over a considerable number of ova in ice. These, however, commenced hatching a few days prior to the opening of the building, and continued doing so up to May 23rd.

All these fish had a double row of teeth along the body of the vomer, from about 112 to 118 rows of scales along the lateral line, from 11 to 12 rows between the adipose dorsal and the lateral line, and 20 rows from the lateral fins to the base of the ventral line. The following give the lengths of the fish, all of which I saw removed from the hatching-trough, as well as the number of bars along their sides.

Length of fish.		Bars on side.	Bars on side.
	inches.		
August 24, 1883. . . .	{ 2.3	9	8
	{ 2.2	9	9
	{ 2.0	10	9
	{ 2.0	8	10
	{ 1.7	8	10
	{ 1.6	8	9
	{ 1.5	9	10
	{ 1.4	8	8
September 27, 1883. .	{ 2.9	9	8
	{ 2.9	8	8
	{ 2.5	7	7
	{ 2.3	9	9
	{ 2.3	7	8

	Length of fish. inches.	Bars on side.	Bars on side.
October 27, 1883	3·3	7	8
	2·9	9	8
	2·8	8	9
	2·8	8	8
	3·5	8	8
November 15, 1883 ..	3·2	9	9
	3·0	9	10
	2·8	8	8
	2·8	8	7
	Average	$8\frac{1}{4}$	$8\frac{1}{4}$

It would appear, from the foregoing, that out of 22 specimens of Mr. Wilmot's young Salmonidæ, the number of parr-bars varied from 7-10, frequently differing in numbers in the two sides of the same fish, while the average was $8\frac{1}{4}$, a remarkable difference from what obtains in the British *Salmo salar*, a question I shall refer to again further on. I may, however, mention here that in some of these fishes the bars were much broken up. The adipose fin in almost all had a leaden-coloured base, the outer two thirds being orange-coloured.

When leaving Teignmouth in Devonshire, in 1882, I had the opportunity of seeing, but not of procuring, two or three long and lanky Salmon, having much the appearance of kelts. I had, however, to postpone my investigations, and went there in August this year, when I was so fortunate as to find the same class of fish, not only in the market there, but also at Torquay, where I went likewise to inquire respecting these fish. In fact, out of the many Salmon which I saw, all were of this local race, evidently the *Salmo gracilis*, Couch, whose examples were taken in the Fowey. Yarrell, on being sent a figure of Couch's fish, replied, "I have a skin of a Salmon that would have been a good match for your female. This was a Salmon that had been detained in a fresh-water pond rather more than three years." Yarrell suggests the water did not suit Couch's fish, but the latter author observes, "It had just come from the open sea," and that the Fowey water is not polluted with poisonous water from mines. It appears to be a variety or local race of *S. salar*.

	Length. inches.	Length of head. inches.	Depth of body. inches.	Weight.
August 21, 1 female	28·0	5·2	5·0	6 lbs.
" "	27·5	5·2	5·2	$7\frac{1}{2}$ lbs.
August 27, 1 male	26·0	4·8	4·0	4 lbs.
" 1 female	24·0	4·5	4·0	4 lbs.

In the foregoing the proportion of the depth of the body to the total length was about $6\frac{1}{2}$ times.

A pair being required for the New South Wales, Sydney, Museum,

Mr. Ramsay and myself procured them ; the proportions were as follows :—

	Male.	Female.
	inches.	inches.
Total length of specimen	26·0	24·0
Length of head	4·8	4·5
Height of body	4·0	4·0
Distance between end of snout and commencement of dorsal fin	10·0	9·0
Length of caudal fin	3·0	3·5
Diameter of eye	0·8	0·5
Distance of eye from end of snout . .	1·5	1·5

These fish had from 118 to 120 rows of scales along the lateral line ; the male had 10 rows, and the female 11 between the posterior end of the base of the adipose dorsal fins, passing downwards and forwards to the lateral line. The male had 61, and the female 71 cæcal appendages. The eggs in the female were about $\frac{1}{20}$ of an inch in diameter, but there were many smaller ones. The milt in the male was appearing, while a small hook was apparent at the end of the lower jaw.

Cooked, they were good fish, not so rich as Salmon from more northern rivers, and of a very slight pink tinge in the flesh. Under what conditions these fish are so elongated, whether from climatic causes or from food, are problems requiring solution. It has been asserted that along the south coast pollution of the river-water is the chief cause¹. It has been generally accepted, that bad, insufficient, or unsuitable food, as well as prevention of descending to the sea at certain periods, will often eventuate in lanky fish, but I do not think that it is generally known that an elongated sea-going race of *Salmo salar* exists.

The Lochleven variety of Trout is that with which Sir J. Gibson-Maitland has had such marked success at Howietoun ; and by keeping those bred in different years by themselves, some exceedingly interesting results have already been ascertained, the prelude possibly to many more. The first of these fish to which I propose adverting are those which are the elders of the fishery, and were hatched in

¹ A correspondent in the 'Field' (January 5, 1884, page 16) observes :—" I have conversed with several old Devonshire anglers, who sadly recall the days of their youth, when they could reckon with a moral certainty on catching two or three Salmon in the Teign with the artificial fly, on any fair fishing day, before the mines had poisoned the river, and who have since then seen a large tract of the stream, extending over three or four miles, so thickly fouled with mine-washings, as to become as lifeless as the Dead-Sea waters. Salmon could not swim or live in such waters for many years. During all this interval the river of course was utterly destroyed for Salmon-fishing, but, strange to say, since the mines have been worked out, some few straggling fish have begun to return in gradually increasing numbers during the last three or four years ; but the taint of the poison still lingers there, and this peculiarity remains, that the flesh of a Teign Salmon is hard and woolly, and utterly devoid of that curded richness which lies between the flakes of a well-dressed fresh-run Severn Salmon."

1875, and placed in the island-pond in 1879, when it was finally completed. This pond is 210×90 feet, and from 10 to 11 feet deep in the centre.

One can hardly assert that the fish thus kept have been under the same conditions of existence as if they had been in a wild state in Scottish waters. Always provided with food, they may have thus been somewhat stimulated, and their powers of propagating their species accelerated. This may tend to shorten life, as sterility in fishes appears to lengthen it. It has been apparent that males experience a larger mortality than females, due apparently to exhaustion after breeding, which seems to be assisted by their pugnacious propensities.

I last year remarked upon the fact observed at Howietoun, that, as a rule, the Lochleven variety of Trout gave eggs of different sizes in accordance with the age of the parents. Those which were hatched in 1876, or six years old, were producing ova 32 of which filled the length of a glass quill, whereas those which were hatched in 1875, or seven years old, gave ova 27 or 28 of which occupied the same space.

Since then I have come across several interesting statements, which fully bear out the observations made at Howietoun. In the Report of the United-States Fish Commission on the McCloud River, for 1878, it is observed that "the parent Salmon were unusually small, their average weight being under eight pounds. This small size was stated to be undoubtedly caused in whole or in part by the fishing at the canneries of the Sacramento, where the 8-inch meshes of the innumerable drift-nets stopped all the large Salmon but let all the small ones through. The eggs when taken proved to be at least a third smaller than those of most previous years, and the average number of eggs to the fish was about 3500 against 4200 in the previous year." In this case the diminished size of the parents may have not only conducted to diminished size of the ova, but likewise to a decreased amount, for the number generally is proportionate to the weight of the parent fish.

Livingston Stone adduces another reason for this result, namely, that American Trout, *Salmo fontinalis*, living in spring water (which means deficient food) develop smaller ova than such as reside in brook water. That is, poverty in food has the same effect in diminishing the size of the eggs as if the parent had not yet arrived at full sexual maturity.

I adduce these instances because assertion has been so confidently made to the contrary, and it is perhaps as well to be able to bring forward facts observed at different places by different observers who are not acquainted with the views of one another. Malmgren having observed that the ova of *Trutta relictæ* are considerably smaller than those of the Salmon, Dr. Günther remarked in the 'Zoological Record' (1864, pp. 180, 181) as follows:—"Thirdly, as Hr. Malmgren observes, in the size of the ova. The last character will be considered very significant by all who may have a more extensive knowledge of fishes, as the size of the ova is not only invariably the same in

individuals of whatever size, but, as far as our experience reaches, is even often characteristic of the species of a genus". Likewise, in his 'Introduction to the Study of Fishes,' 1880, p. 159, he observes, "The ova of Teleosteous Fishes are extremely variable in size, quite independently of the size of the parent species. The ova of large and small individuals of the same species, of course, do not differ in size."

This brings us to the consideration of whether it is possible that increased size of eggs may lead to augmented size of offspring, irrespective of the question of changing the locality they inhabit, or increasing the space or amount of water in which they reside.

The following interesting experiment was instituted fourteen months since by Sir James Maitland. Two batches of Lochleven Trout were spawned in the winter of 1882 on November 2nd, the parents of one having been hatched in 1875, and of the other in 1876. The eggs were similarly treated, and hatched in January and February 1883.

In the garden in front of Sir J. Maitland's house at Craigend two ponds have been constructed for the reception of young fish, each of the same width and 100 feet long; one is nearly on a level with the other, and the same stream runs through each. Into these ponds the two lots of fry were turned—those from the older or 1875, or seven years' old parents, having the lower pond; those from the younger or 1876, or six years' old parents, having the upper pond, while they were fed and treated in an identical manner.

On November 29th we examined these two ponds, the fry in the upper of which, or from the younger parents, seemed to average about $2\frac{1}{2}$ inches in length, while those in the lower pond appeared to average about $3\frac{1}{2}$ inches in length; showing that from the eggs of the older parents had emanated the more satisfactory offspring.

We next proceeded to draw a net through each pond; and I selected three young fish from the upper and five from the lower series as among the finest examples of each batch. These fish gave the following results:—

Upper pond, from 1876 parents.		
Length. inches.	Bars.	Bars.
3·5	13	13
3·0	13	12
2·9	14	13
Average	3·1	$13\frac{1}{3}$ $12\frac{2}{3}$

These fish were more spotted than those in the lower pond and had more red marks. The dorsal fin had a white front edge, as in young Brook-Trout

¹ Genus *Brachymystax*, Günther. "Even if *Salmo fluviatilis* should prove to be the male of *Salmo coregonoides* (the type of the new genus), still the small size of the ova would be a character of sufficient importance to separate these fishes generically from *Salmo*." Catal. Fish. Brit. Mus. vi. p. 163.

Lower pond, from 1875 parents.

	Length. inches.	Bars.	Bars.
No. 1.....	4·0	13	12
No. 2.....	4·0	14	12
No. 3.....	3·8	11	12
No. 4.....	3·9	13	14
No. 5.....	3·9	12	13
Average....	3·9	$13\frac{3}{5}$	$12\frac{3}{5}$

These fish had the parr-bands somewhat more broken up than those in the upper pond, while the bands varied from 11 to 14; they were otherwise similarly coloured.

If these averages are reliable, and I consider them to be so, among the thousands of fish I saw in these two ponds, the increase or difference or gain in length by selection of parents was nearly one fourth of the total length of the fish at nine months of age, or in those whose parents were hatched in 1875 over those whose parents were hatched in 1876. As these larger-bred fish are likely to form a larger race, a sufficiency will be retained for breeders; time, however, can only show to what extent this will be realized.

But although experience has shown that the eggs of the older fish produce larger fry, and such as are better calculated to fight the battle of life, the problem had to be solved up to what age can breeding from Trout be continued with a reasonable prospect of remuneration; for it is clear that keeping sterile or scarcely prolific fish would hardly be advantageous, while as soon as a diminution of the vital powers sets in, it is reasonable to suppose that the limit of obtaining the finest offspring has been reached. Some of these questions seem to have met with a most unexpected answer this year at Howietoun, where the old fish have experienced a most extraordinary mortality, not simply due to fungus¹, but apparently consequent upon age. First the males of these eight-year-old fish commenced to succumb², subsequently the females, many of which latter were egg-

¹ Fungus appears to attack most virulently old males and unspawned females, but very rarely young fish. It would almost seem nature's mode of clearing off kelts, which feed on the young fish, and are consequently injurious to salmon-rivers. This likewise accounts for the fact that in certain rivers where the disease has been most virulent, the succeeding year's supply of Salmon has been abundant. Possibly there will be less monsters in number, the remnants of last year's kelts, but the amount of moderate-sized fish will more than compensate for this.

² In a letter from New Zealand in the 'Field' (Dec. 15th, 1883) it is observed:— "In a great many of the creeks, after the fish get to 6 pounds weight, they seem to fall off in condition and get long and thin, and grow greatly to head." Now is this due to age or feeding? If we take 8 years as about the age at which Trout fall off, and deduct this from 1883, we come to 1875. The first *Salmo-fario* ova which arrived in safety at Melbourne and Tasmania were in 1864, and we are told that "during the years 1873, 1874, 1875, and 1876, . . . 33,850 Trout ova and fry have been distributed to suitable streams in Tasmania, New Zealand, Victoria, New South Wales, and Western Australia" (Nichols, 'Acclimatization of the Salmonidæ at the Antipodes,' 1882, p. 85).

bound, not a few were sterile, while the number of eggs from those ripe for breeding were, fish for fish, less than in 1882. Taking all things into consideration the time appeared to have arrived when the paying value of most of these Trout had come to an end, and it was decided that they could no longer be kept with advantage. The sluice was therefore opened on November 27th, and the next morning we proceeded to the pond to select such fish as were worth preserving and spawn such as proved to be ripe.

On arriving at the pond the water was found to have nearly run down, and in the mud at the bottom were many dead Trout, not short of 100, the majority of which were about two feet in length, some kelts, some egg-bound females, while a few were floundering in the mud. On removing with a net the remaining fish, it was observable that a change in the colour of some had occurred; and the same change was observed among some of the 1876 Lochleven Trout—namely, that the anal fin had a white edge and the anterior-superior margin of the dorsal fin was also white, thus reverting to the Brook-Trout form of colour. Attention may likewise be drawn to all the hybrids between this form of Trout and the Salmon possessing a white edge to the dorsal and anal fins. Those who consider colour as indicating a specific difference in these fish differentiate the Lochleven from the Brook-Trout by the latter possessing a white edge to their fins, which is deficient in the former. These old and undoubted Lochleven fish are throwing back in colour to the Brook-Trout livery; and likewise among the crosses between this variety and the Salmon we find the white edge to the fins as seen in the Brook-Trout invariably present, although absent from the parents.

On placing a net in the ditch into which the island-pond drained, a considerable number of Trout-ova were found in it. Whether these were from the bottom of the pond, or whether an old female had got jammed in the valve and her eggs discharged, it was not possible to say, but they were white and opaque, as if they had been exuded longer than 12 hours.

Forty-two large Trout had to be killed as evidently passé, and about 300 of the remainder were removed to another receptacle. The small amount of fertile males was remarkable; while all the old ones had the hook at the end of the lower jaw. Among the fish in this pond were some of the hybrids between the Salmon and Trout, bred from ova taken in November 1879, and already adverted to.

On November 15th, 1882, Sir J. Gibson-Maitland in my presence obtained about 2000 ova from a Lochleven Trout, which were fertilized with milt from an American Brook-Trout, or Charr, *Salmo fontinalis*. These were placed in hatching-box no. 108, and on November 29th, 1883, about 150 were alive. They had been transferred to a large wooden rearing tank through which a stream of water flowed. The mortality among these 2000 eggs had been as follows:—November 68, December 142, January 89, February 41, or a total of 340 eggs. The young were much malformed, monstrosities being numerous, blindness in both or in a single eye, and bull-

dog deformities of the snout being the most perceptible: some were very light-coloured, but not quite albinos, as the markings, although pale, were visible; and in such as have survived this want of colour still continues.

In May 1883 I received from Sir J. Maitland one of these fish from the hatching-house: it was 0·8 of an inch long, the anterior portion of its head deformed from want of development of the pre-maxillaries and contiguous bones; its colour was white without any markings.

July 20th, 1883, I removed from box 108 some more of these fishes, which were as follows (in inches and tenths):—

	No. 1.	No. 2.	No. 3.	No. 4.
Total length	1·7	1·7	1·7	1·6
Length of head	0·4	0·3	0·4	0·4
Length of caudal fin . .	0·3	0·25	0·3	0·3
Height of body	0·3	0·3	0·3	0·3
Number of bars	8 & 9	9 & 11	9 & 9	9 & 10

November 29th, the following three fishes were removed from the box:—

Total length	2·7	2·6	2·2
Length of head	0·6	0·6	0·4
Length of caudal fin . .	0·4	0·5	0·3
Height of body	0·5	0·55	0·4

No. 1 was blind of the left eye, but no perceptible difference could be seen in the colours of the two sides, which were similar to those in No. 2, except having two bands instead of one across the dorsal fin. There were 17 rows of scales between the posterior extremity of the base of the adipose dorsal fin, passing downwards and forwards to the lateral line: in Trout there are normally from 13 to 15, and in American Charr from 21 to 26.

No. 2 had the eyesight apparently normal. The finger-marks along the sides were broken up into arched bands or circles enclosing spaces, the ground-colour being yellowish; the upper surface of the head and back spotted and marked with black dots; the rayed dorsal fin with a dark band across its centre and a dark spot at the base of its first ray. There were 22 rows of scales between the adipose dorsal fin and the lateral line.

No. 3 had the right eye lost, the ball having retracted into the socket; while the left eye was almost blind, the pupil being reduced to a small slit, while a black-coloured spot was present on the sclerotic. When alive this fish appeared as one of the semi-albinos which I have referred to: the markings were present, but light on both sides, more especially so on the right. There were 15 rows of scales between the adipose dorsal fin and the lateral line.

On November 15th, 1882, 8000 ova were taken from an American Charr, *Salmo fontinalis*, which were fertilized with milt from a Lochleven Trout as in the last experiment, the eggs and young being

similarly treated. These eggs were placed in box 104, and on November 29th, 1883, 16 remained alive. The mortality among these 8000 eggs was as follows:—November 28, December 575, January 1818, February 297, or a total loss of 2718. The young fry were greatly deformed, many had their spines crooked, atrophy of its posterior portion, and a deficiency of the fins generally, more particularly of the caudal.

May 1883, the young were about one inch in length and had about 11 finger-marks, the foremost four of which were mostly below the lateral line, while the remainder generally crossed it. I received one specimen from Sir J. Maitland, which was 0·8 of an inch long: its head and the anterior portion of its body was natural, but posterior to the dorsal fin a general atrophy had occurred, and although the anal fin was fairly developed, the caudal portion was embryonic. It had six bars along each side.

July 20th, the cross bands had become much wider, passing downwards to the belly and upwards towards the back, which, however, they do not reach, but small and irregular bands descend towards the spaces between the cross bands. The broad cross bands on the sides of the body are twice as wide as the interspaces, generally about nine in number, while another crosses over the head, covering a portion of the gill-covers, and a dark band runs along the middle of the dorsal fin. I removed three from the boxes, which were of the following sizes (in inches and tenths).

	No. 1.	No. 2.	No. 3.
Total length	1·8	1·6	1·5
Length of head	0·5	0·35	0·4
Length of caudal fin . .	0·3	0·25	0·3
Height of body	0·5	0·3	0·3
Number of bars	8 & 10	10 & 11	9 & 8

November 29th, the following fish was removed from the remaining 16.

Total length	2·1 inches.
Length of head	0·5 inch
Length of caudal fin . . .	0·4 „
Height of body	0·4 „

The finger-marks in this specimen appear to have been about 12, but are broken up into irregular shapes, reticulating over the body, which is of a yellow colour. Similarly along the back the fish appears covered with black spots on a yellow ground. Dorsal fin with two oblique black bands, a light upper edge, and a dark spot at the base of its first dorsal rays. There were 15 rows of scales between the adipose dorsal fin and the lateral line.

It is interesting to observe that about one in six of the eggs of the Lochleven Trout impregnated by the American Charr failed to hatch, but double that number, or one in three, of the American Charr-eggs

impregnated from Lochleven Trout-milt. The same reason which appears to militate against Trout-eggs being impregnated by Salmon-milt probably is the cause, *i.e.* the size of the spermatozoa. Thus the comparatively large Lochleven Trout-eggs were fertilized from the milt of the Charr; but when the converse was tried the success was much less. As the American Charr-eggs are much smaller than those of the Lochleven Trout, it is reasonable to suppose the spermatozoa are also smaller, and consequently were readily absorbed; but when it was attempted to fertilize the *Salmo fontinalis* by the milt of *S. levenensis*, probably the large spermatozoa did not readily find entrance, thus accounting for the great proportion of unhatched ova.

Among the *Salmo fario*, or Brook-Trout, which in the upper pond are going on for 8 years of age, a considerable amount of fungus was present. It has been observed, similar to what obtains in the Lochleven variety, that the size of the eggs augments with age.

An exceedingly interesting subject of investigation is whether we possess several or only one species of River-Trout. The foregoing descriptions of hybrids show that, although neither the Salmon nor Lochleven Trout possesses white edges to the dorsal and anal fins (such being usually restricted to the Brook-Trout), hybrids between the two appear invariably to be so marked. This year's investigations at Howietoun have likewise shown that such a mode of colour may occur in old Lochleven Trout, especially males.

I have several times observed that all lines of demarcation between the recorded species become obliterated should the ova of these fish be transmitted to foreign lands, where, due to changes in diet, temperature of the water, and other causes, *Salmo ferax* may be raised from the egg of our common Brook-Trout. The first and last arrival of the eggs of the British Brook-Trout (*Salmo fario*) at Tasmania occurred April 24, 1864. Some of these ova were collected by Mr. Frank Buckland from fish in the stream running through Admiral Keppel's garden on the Itchen in Hampshire, while Mr. Francis Francis's were obtained from a mill at Alton on the Wey, and from Mr. Thurlow's mill at High Wycombe, Buckinghamshire; and Mr. Arthur tells us that the first successful Trout-hatching in Otago occurred in October 1868, from 800 eggs obtained from the natural spawning-beds of *Salmo fario*, in Tasmania. These, and a second lot the subsequent year, formed the whole of the original stock which were first liberated in the streams in November 1869. As these Trout were raised from eggs derived from our southern or smallest variety, where the great Lake-Trout, *S. ferax*, is not found, it is clear that *S. ferax* ought not to be present in Otago, unless this latter fish is merely a variety of our Brook-Trout.

Mr. W. Arthur most kindly forwarded to me, in ice, from the Otago Acclimatization Society, by S.S. 'Tonic,' which left Lyttelton, New Zealand, on July 9, 1883, two specimens of Trout recently taken, this being their spawning season. "They were got in a small river not 20 feet wide, which runs into a freshwater lake,

Lovells Cruter, a feeder of the Tuakitoto Lake, situated about 15 miles from the sea. They are large fish in good condition: the male weighs 16 to the female 12 pounds. These fish have evidently not been frequenting brackish or saline waters, at least the total absence of $\times$ spots is, I suppose, according to the authorities, proof of such a fact, and the spots of these fish now sent are round and oval. I observed that the vomerine teeth are all gone, and only one or two ancient tusks still on that bone of the female; so age affects teeth similarly to migratory habits."

The following are the characters of this pair of Trout, which were received in excellent condition, and are now preserved in spirit in the Economic Fish Museum:—

<i>Male.</i>	Length of fish.....	32 $\frac{1}{2}$ inches.
	„ head.....	6 $\frac{1}{2}$ „
	„ caudal fin..	4 $\frac{1}{2}$ „
	Height of body.....	7 „

Eye. Diameter 1 inch, 3 inches from end of snout, and 3·2 inches apart.

L. l. 118, and 12 rows of scales from the adipose fin, downwards and forwards to the lateral line. *Teeth* none on the vomer, some on the palate, some on the tongue in two rows, four in each. The maxillary reaches to $\frac{2}{3}$ of a diameter behind the eye. *Colours*: dark spots over the body, shoulder, and dorsal fins.

<i>Female.</i>	Length of fish.....	31 $\frac{1}{2}$ inches.
	„ head.....	6 $\frac{1}{4}$ „
	„ caudal fin..	4 $\frac{1}{2}$ „
	Height of body.....	6 $\frac{1}{2}$ „

Eye. Diameter 1·55 inch, 1·6 inch from end of snout, and 2·4 inches apart.

L. l. 120; 14 rows of scales from the adipose fin downwards and forwards to the lateral line. *Teeth*: a few on the front of the vomer. Caudal fin emarginate. *Colours*: spotted all over the body.

These two beautiful specimens of Trout are so exceedingly similar to so-called Lake-Trout, that any ichthyologist who believed in the numerous species of this fish, and was unaware from whence they came, would undoubtedly term them *Salmo ferox*.

As a considerable stress has, erroneously I believe, been laid upon the number of cæcal appendages among the Salmonidæ, as diagnostic of species, I give the following table:—

Dr. Günther.	Anadromous forms.	<i>Salmo salar</i>	Cæc. appen. 51-77.
„	„	— <i>argenteus</i>	„ 61-67.
„	„	— <i>trutta</i>	„ 43-61.
„	„	— <i>orcadensis</i>	„ 50.
„	„	— <i>brachypoma</i>	„ 45-47.
„	„	— <i>cambricus</i>	„ 33-52.

Dr. Günther.	Non-migratory forms.	<i>Salmo levenensis</i>	"	49-90.
"	"	— <i>fario</i> , var. <i>gaimardi</i>	"	33-46.
"	"	— — var. <i>ausonii</i>	"	38-47.
"	"	— <i>ferox</i>	"	43-49.
"	"	— <i>stomachicus</i>	"	44.
"	"	— <i>gallivensis</i>	"	44.
"	"	— <i>nigripinnis</i>	"	36-42.
Mr. Day.	Non-migratory forms.	<i>Salmo fario</i> :—		
		Gloucestershire	Cæc. appen.	34-39.
		Cornwall & Cardiganshire	"	35-44.
		Yorkshire	"	35.
		Sutherlandshire	"	46.
"	"	<i>Salmo levenensis</i> :—		
		At Howietoun	"	47.
"	"	4 <i>S. salar</i> & <i>S. levenensis</i>	"	{ 61, 62,
"	Migratory form	2 <i>S. salar</i> , Devonshire ...	"	{ 69, 78.
Mr. Arthur.	Non-migratory form	<i>Salmo fario</i> , var. <i>ausonii</i> , New Zealand.	"	61, 71.
			"	43-54.

I do not propose referring to the foregoing, as I have elsewhere (British and Irish Fishes) entered on a consideration of how the Brook-Trout, transported to a warmer climate, and where food is abundant, has taken on a structural change, conclusively showing that the number of cæca is not invariable, but changes with changing circumstances, and consequently cannot be a criterion of species; for all the eggs of the Brook-Trout sent to Tasmania were from districts considered by Dr. Günther to be inhabited by the race *ausonii* of *Salmo fario*, in which he had found from 38 to 47 cæcal appendages only: the same result of change being likewise shown in the transference of Lochleven Trout to Howietoun.

I do not propose arguing upon the foregoing premises, but they may tend to prove that in undoubted hybrids the percentage hatched is comparatively small, that the number of malformations is great, and the young appear to be sickly. On the other hand, it does not seem unreasonable to almost doubt whether there exists specific difference between the American and British Charrs, monstrosities being rare, and the young strong. The sole male Charr employed had been some time ready for spawning before being used, and doubts were expressed at the condition of the milt. After one or two years' more enquiry, a trustworthy answer may be given; but so far as hybrids from Howietoun have gone, sterility appears to be the rule, as yet no exceptions having been noticed, but the examples have been few.

Much stress has been laid upon the number of finger-marks or transverse bars along the sides of various forms of Salmonidæ, as characteristic of species. Thus in the second edition of the Parr Controversy (1883) we are told (p. 126) that in the Salmon there are nine or ten, but in the Trout only six or seven; while those of the Charr are not alluded to. Dr. Günther, in his 'Introduction to the Study of Fish,' repeats the popular idea when he observes, "The number of bars is not quite constant, but the migratory Trout have 2 (and even 3) more than the River-Trout" (p. 631).

Although it appears pretty evident that the number of these parr-bands may slightly vary with the age of the fish, and that they may be broken up in some forms, it is still clear that very great latitude must exist, as we find them occasionally of different numbers on the two sides of the same fish. I will now give the figures showing the bands as existing in the specimens to which I have referred, and most of which are now on the table.

Three Salmon smolts, hatched March 1881, had, when captured on November 29th, ten finger-marks on either side.

Two Salmon smolts, from the Hodder, each about seven inches long, had nine or ten finger-marks on each side.

Twenty-two Salmon-fry, the eggs of which came from Canada, gave the following results:—

Eight specimens at 3 months of age: the bars averaged $8\frac{7}{8}$ on each side of the fish, eight was the smallest number, ten the largest; and the greatest difference in number between the two sides of one fish consisted in eight on one side and ten on the other.

Five specimens at 4 months of age: the bars averaged eight, while seven was the smallest and nine the largest number; in one fish there were nine on one side and eight on the other.

Four specimens at 5 months of age: the bars averaged $8\frac{1}{4}$, while seven was the smallest and nine the largest number; the difference between the numbers of bars on the two sides of any fish did not exceed one.

Five specimens $5\frac{1}{2}$ months of age: the bars averaged $8\frac{4}{5}$, while seven was the smallest and ten the largest number; the difference between the numbers of bars on the two sides of any fish did not exceed one.

The general average of bars in these twenty-two specimens was $8\frac{1}{4}$, and only twelve out of the twenty-two had so many as nine or ten bars, while in one specimen they did not exceed seven; the same number being on one side of three others. All the examples of young Salmon had from seven to ten finger-marks along the sides.

Among the hybrids between the Salmon and the Lochleven Trout, on November 15th, 1881, three specimens at 8 months of age had from ten to thirteen finger-marks along the sides. Three of the same batch were captured November 29th, 1883, at 20 months of age: one had twelve bars on both sides, one ten on one side and twelve on the other, and the remaining fish ten on one side and eleven on the other, showing a variation of from ten to twelve bars.

Among four hybrids between Lochleven Trout and American Charr, captured November 29th, 1883, at 5 months of age, the average number of bars was $9\frac{1}{4}$, the least number being eight, the most eleven, and the greatest difference between the two sides of one fish being two. This shows a higher number of bars than were seen in the young of the true Salmon at Howietoun at the same age, or at the Fisheries; while only Trout and Charr blood were mixed. As the fish got older these bars broke up and could not be counted.

Among three hybrids between the American Charr and the Lochleven Trout, captured November 29th, 1883, at 5 months of age,

the average number of bars was $9\frac{1}{3}$; the least number being eight, the most eleven, and the greatest difference between the two sides of one fish being two.

Among eight pure Lochleven Trout at 9 months of age, captured November 29th, 1883, the average number of bars was $12\frac{3}{4}$; the smallest number being eleven and the largest fourteen, the greatest difference between the two sides of one fish being two. These figures are remarkable as showing that at Howietoun the average number of bars in the Lochleven Trout exceeds that observed in the young Salmon.

Among four young American Charr, captured November 29th, 1883, the average number of bars was eight, the smallest being seven and the largest ten, the greatest difference between the two sides of one fish being one.

Among four hybrids, or rather crosses, between the American and Scotch Charr, captured July 20th, 1883, when they were five months old, the average number of bars was $9\frac{1}{2}$, the smallest being eight, and the largest eleven, the greatest difference between the two sides of one fish being two.

Among two more hybrids of the same lot as the last, but captured on November 29th, 1883, at nine months of age, the average number of bars was $11\frac{3}{4}$, the smallest being eleven, and the largest thirteen, the greatest difference between the two sides of one fish being two. In this case it appears as if the number of bars has been augmented with age.

So far as the evidence of the foregoing specimens bears upon the question of the number of parr-bands along the sides of young Salmonidæ, they may be summed up as follows:—

	Average.	Largest number.	Smallest number.	Greatest difference.
3 <i>Salmo salar</i> , at Howietoun.....	10	10	10	0
3 " " from the Hodder ...	$9\frac{3}{4}$	10	9	1
22 " " from Canada.....	$8\frac{1}{4}$	10	7	2
3 Hybrid <i>S. salar</i> and <i>S. levenensis</i> .	$11\frac{1}{6}$	12	10	2
4 " " " " " "	$11\frac{1}{6}$	12	10	2
4 Hybrid <i>S. levenensis</i> ♀, <i>S. fontinalis</i> ♂	$9\frac{1}{4}$	11	8	2
3 Hybrid <i>S. fontinalis</i> ♀, <i>S. levenensis</i> ♂	$9\frac{1}{3}$	11	8	2
8 <i>Salmo levenensis</i>	$12\frac{3}{4}$	14	11	2
4 <i>Salmo fontinalis</i>	8	10	7	1
4 Hybrid <i>S. fontinalis</i> ♀, <i>S. alpinus</i> ♂	$9\frac{1}{2}$	11	8	2
2 Hybrid <i>S. fontinalis</i> ♀, <i>S. alpinus</i> ♂	$11\frac{3}{4}$	13	11	2

It appears to be a fallacy that the Salmon or migratory Salmonidæ have more parr-bands than forms of non-migratory Trout—those of the Lochleven Trout at Howietoun, provided the foregoing averages are accurate, showing the greatest number of these marks; while the Canadian *S. salar* gives an extraordinarily small average, only equalling the American Charr.

It is difficult to make out the number of bars along the sides in

Shaw's woodcuts; but it appears from Yarrell's work, 'On the Growth of the Salmon in Fresh Water,' that the numbers are as follows:—

Shaw	found at	1.0 inch in length	9 bands.
"	"	1.2	" " 13 or 14 bands
"	"	2.9	" " 16 bands
Yarrell	"	3.5	" " 9 "
"	"	4.3	" " 11 "
"	"	6.1	" " 10 "
"	"	6.3	" " 11 "

But without descriptions it is not safe to go by figures respecting the modes of colouring.

American Charr or Brook-Trout, *Salmo fontinalis*. About 8000 fry were turned into a large wooden box, which measured 20 × 18 feet. These fish were hatched in January 1883, and the water in which they have lived has remained at an average of about 44°. This species does well in a wooden tank indoors for a year, in which respect it differs from the other Salmonidæ. But out of doors it seems to be rather delicate, and the older females, unless spawned as soon as ready, are very subject to fungus, and die egg-bound; the males likewise are very often victims to this disease.

November 29th, 1883, these young fish in the tank appeared to be very healthy; four were removed for examination, and are now on the table.

		inches.	Bars.	Bars.
No. 1.	Length of fish	3.5	10	10
No. 2.	" "	3.5	8	9
No. 3.	" "	3.5	7	7
No. 4.	" "	2.1	7	7
Average		3.1	8	8

It would appear that, judging from these few examples, the smaller fish have the least number of bars; but there are many intermediate half bars which only descend to the lateral line or a little below it. All of them had a few fine teeth on the head of the vomer, but none on the body of that bone.

On November 15th, 1882, Sir James Maitland obtained 9000 ova from the American Charr, which were fertilized by the milt of a Charr obtained from Loch Rannoch, and which had been retained in one of the boxes. There was a little doubt expressed at the time respecting the milt, which was rather thick. The eggs were placed in box No. 116, and on November 29th, 1883, about 65 were alive, all being well-grown fish. The mortality among the 9000 ova was as follows:—November 28, December 30, January 1907, February 130, or a total loss of 2104. Probably this mortality may have been due to deficiency of fertilization. The young showed no amount of monstrosities or malformations, and have done well.

On May 20th I received one, $1\frac{1}{4}$ inch long, having 8 broad cross bands and many small intermediate ones; no band on the dorsal fin.

On July 20th, 1883, I removed the following four from box No. 116 :—

		inches.	Bars.	Bars.
No. 1.	Length of fish	2·1	9	11
No. 2.	„ „	2·0	8	9
No. 3.	„ „	1·8	9	11
No. 4.	„ „	1·3	10	9
Average		1·8	9	10

In some of these specimens the cross bars were much more broken up on one side of a fish than they were on the opposite ; one had 9 wide ones, another had 6 to opposite end of dorsal fin, after which they were broken up. All had the light anterior edge to the first dorsal fin. None were deformed.

On November 29th, 1883, the following two fish were taken from the tank :—

	No. 1.	No. 2.
Length of fish	3·0 inches.	2·8 inches.
„ head	0·6 „	0·6 „
„ caudal fin	0·5 „	0·45 „
Height of body	0·5 „	0·5 „

Specimen No. 1. D. 14 ($\frac{4}{10}$). P. 14. V. 9. A. 11 ($\frac{3}{8}$). C. 19. L. 1. 136.

Colours. This fish had about 13 bars or finger-marks along one side and 11 along the other, but somewhat irregularly placed, most extending to below the lateral line, while they were of varying widths, with generally an intermediate row above and another below. Numerous light spots over the body and head running into irregular bands and rings, especially near the back. Dorsal fin darkest in its lowest half, and with some light spots, the other fins unspotted. The maxilla reaches to beneath the posterior third of the eye. 28 rows of scales between the adipose dorsal fin and the lateral line.

Specimen No. 2. D. 13 ($\frac{4}{9}$). P. 14. V. 8. A. 11 ($\frac{3}{8}$). C. 19. L. 1. 124.

Colours. This fish had from 11 to 12 bars or finger-marks along either side of the body, but they were much shorter and more irregular in shape and size than in the last, while below the lateral line it had fewer and smaller intermediate blotches. The marks also along the back were more irregular. Teeth along the head of the vomer, none along the body of the bone. 20 rows of scales between the adipose dorsal fin and the lateral line.

The following formula I have found existing in some specimens of Scotch and American Charr :—

	Dorsal fin.	L. 1.	Rows from adipose dorsal to lateral line.
Scotch	D. 12-14.	125-145.	18-28.
American . .	D. 12-13.	122-140.	21-26.
Hybrids . .	D. 13-14.	124-136.	20-28.

Considering that these fishes have shown no tendency to monstrosities, have been well formed, and grown fairly in proportion to the young of the true American Charr hatched at the same time, I cannot resist thinking that it may be possible that these two fish, although so widely differing in colour, may be merely varieties of one species, descendants from one common stock. This question, however, will be more appropriately discussed when we possess fish a year or two older.

On November 29th, 1883, about 4500 eggs were obtained from a Lochleven trout which had been hatched in 1875, and these were milted from a young Salmon, such as I have already described, which was taken for this purpose from pond C. 130. These eggs were deposited in box 88.

About 3000 eggs were taken from a Lochleven Trout of the season of 1875, and fertilized from the milt of two American Charr. These eggs were deposited in box 92.

About 2695 eggs were taken from an American Charr and milted from a young Salmon from pond C. 130. These ova were deposited in box 96.

About 1000 eggs were obtained from a Brook-Trout of about 1lb. weight and fertilized from the milt of the dead young salmon already referred to. These eggs were deposited in box 100.

5. On the Generic Position and Relations of *Echinanthus tumidus*, Woods: By F. JEFFREY BELL, M.A., Sec. R.M.S., Professor of Comparative Anatomy in King's College.

[Received December 18, 1883.]

(Plates II. & III.)

For some years past our knowledge of the Echinoidea has been increased by the descriptions of various new species, published by the Rev. J. E. T. Woods, which have appeared in the 'Proceedings' of that excellent body the Linnean Society of New South Wales.

Of such forms the most remarkable was that which was distinguished by him as *Echinanthus tumidus*¹; my knowledge of this species was confined to the short description which he gives of it, but that description was sufficient to rouse my curiosity. It was, therefore, with the greatest pleasure that I found an example of it among a set of specimens which Mr. E. P. Ramsay lately submitted to me for determination. The original diagnosis had made it clear to my mind that the species did not belong to the genus *Echinanthus*; and an investigation of the characters of the specimen itself lead me to the belief that it presents very important points of difference from any form yet described.

¹ Proc. Linn. Soc. N. S. W. ii. p. 169.